2007

Research Update Meeting 2007 - Frost and Moisture Workshop 2007

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Frost protection, irrigation scheduling and sensor technology

Mini Workshop

Frost Protection

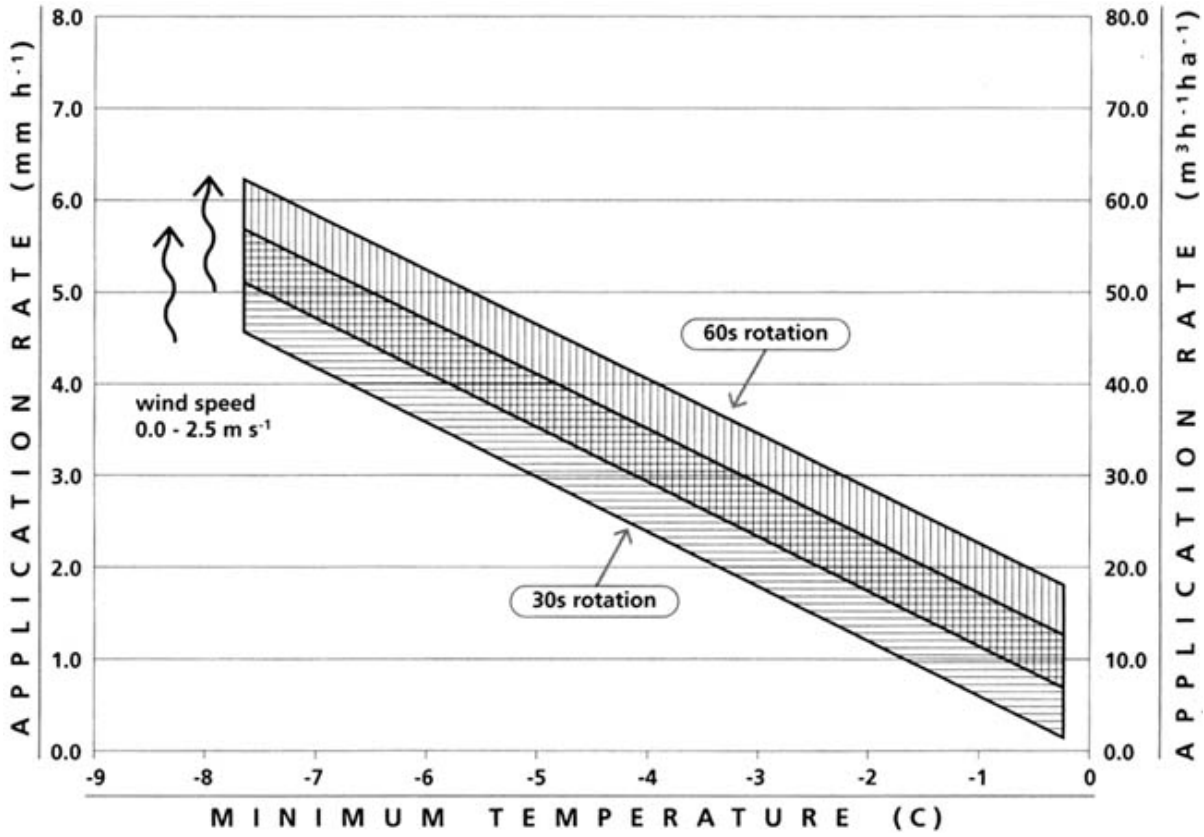
Basics of sprinkler protection

- How sprinkling works
  - Heat of fusion as water freezes
  - Balance rate of application with rate of freezing
  - Must stay wet!! (ice should be CLEAR with water dripping)
  - What about when no ice forms? – cooling water releases heat even if it doesn't freeze

Frost Protection

Basics of sprinkler protection

- How much water needed?
  - If calm -- 0.1”/hr protects to ~25F
  - Need more for lower or if air moving or for slow rotations



Frost Protection

Basics of sprinkler protection

- When to start
  - 1-2º above tolerance
  - If manual turn-on alarm must be set even higher
  - How accurate is your thermometer?

- Which T?
  - Air
  - Wet-bulb (not an issue for continuous sprinkling)

Frost Protection

Basics of sprinkler protection

- When to stop
  - When ice begins to melt
    - if wind picks up and melting stops evaporation can be a problem (heat loss is more than with melting)
  - Sun on the plants
  - Both usually by 7:30 at the latest
  - Above tolerance by 3+ degrees (wet-bulb?)

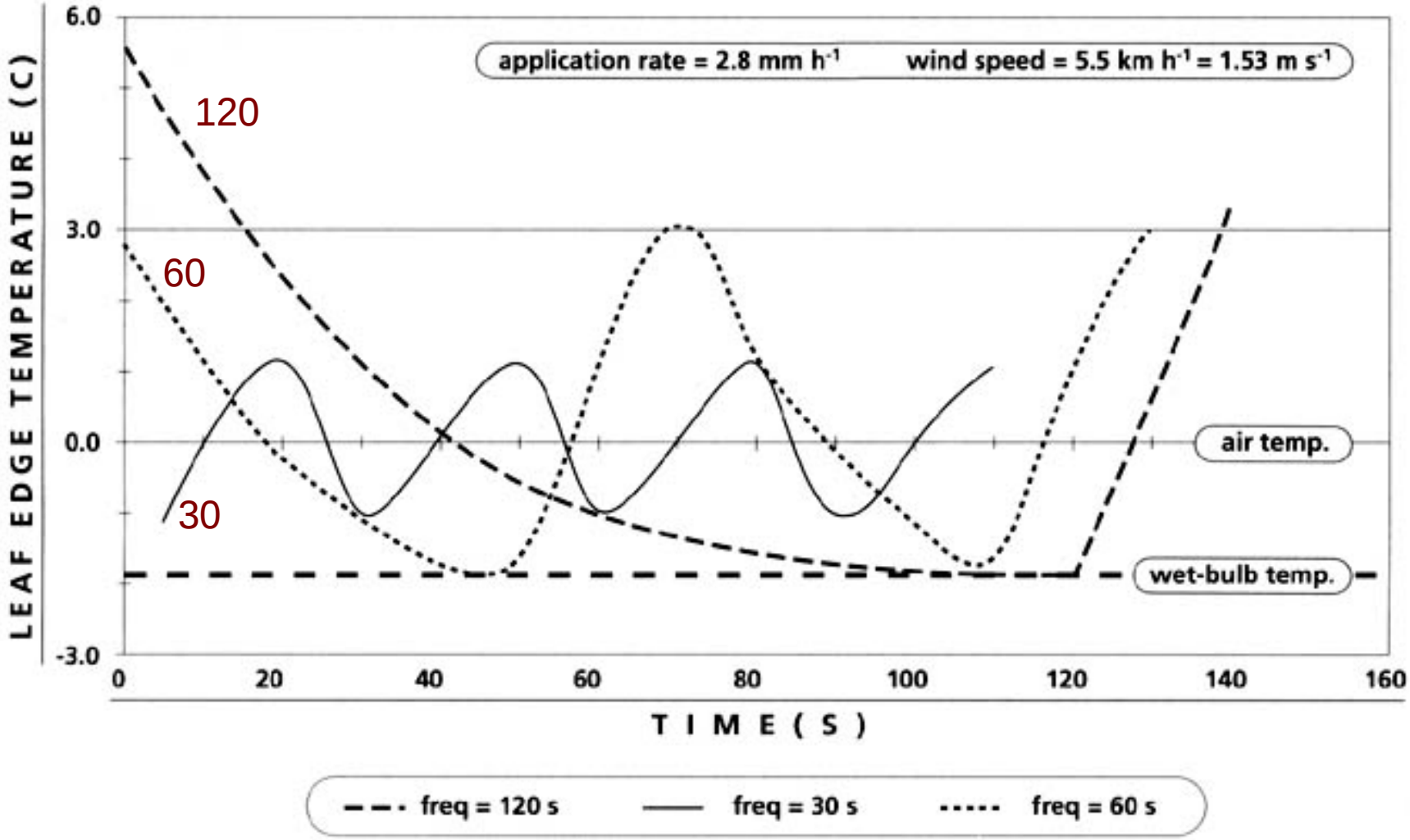
Frost Protection

Intermittent sprinkling – concepts

- Depends on T and Humidity
- T of wet plant will tend to fall to ‘wet-bulb’ T if sprinklers off (wet-bulb determined by T and dew point)
- Would need to know how wet-bulb compares to tolerance
- Wet-bulb is generally less than air (dry-bulb) T – lower dew point – more separation of wet-bulb and air T

FIGURE 7.10 (ftp://ftp.fao.org/docrep/fao/008/y7223e/y7223e00.pdf)

Leaf-edge temperature changes when wetted by a sprinkler system applying water at 2.8 mm h^{-1} with rotation rates of 120, 60 and 30 s, air temperature near 0 °C, a wet-bulb temperature near -2 °C and a wind speed near 5.5 km h^{-1} (after Wheaton and Kidder, 1964)



Frost Protection

Intermittent sprinkling - orchards

- Pulsing/cycling
  - Short cycles – 2 minutes on and off
    - On = rotation time (get at least one rotation but this can fail if coverage not excellent)
    - Off = no more than 3 min.
- Computerized orchard system
  - 75% water savings
  - Use environmental parameters and bud T in model controlling on and off periods (minimum on time 1 min.; maximum off time 3 min.)

Frost Protection

Intermittent sprinkling – how to control

- Use wet-bulb T (mimics the wet plant)
  - Or the proper sensor in the wet area
    - Placement critical
    - Ice buildup could lead to longer ‘on’ time
- Use exposed sensor outside wet area?
  - Base protocol on temp here
  - Orchard model used 1 min on/off at moderately cold T, all on at lower T

- Questions?
- Grower experiences

Temperature sensing

Compare devices

- Glass thermometers
  - Accurate
  - Moderate response
  - Affected by wetting
- Thermocouples
  - Moderately accurate
  - Relatively fast response
  - Sensitivity can be low

Temperature sensing

Compare devices

- RTD (resistance)
  - Very accurate
  - High sensitivity
  - Moderate response time
- Semi-conductor thermistors
  - Accurate
  - Responsive – but may not be as fast as you think
  - Fragile / Subject to self-heating

Temperature sensing

Compare devices

- Hand-held IR
  - Accurate?
  - Good response time
- Others?

Temperature sensing

Questions

- Sensors do not match glass thermometer
- How to calibrate to each other – ice water bath result doesn't seem to hold when they are moved to the field
- Are these lag issues? Sheltering issues?

Temperature sensing

Questions

- Coyotes?
- Wireless?
- Sensor placement

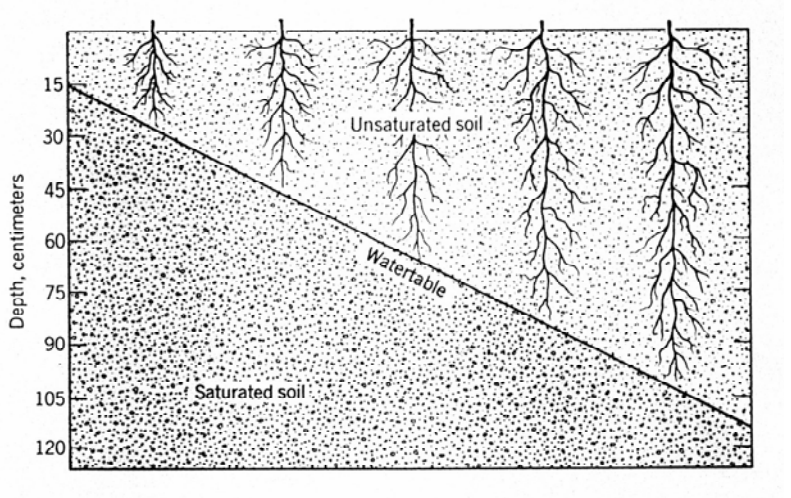
- Questions?
- Grower experiences
- Expert information

Irrigation scheduling

- Use of methods other than the inch-a-week rule

Why is it important?

- Saturated conditions (especially in spring)
  - Poor root development
  - Poor nutrient uptake
  - Poor release and utilization of nitrogen



- Too little water
  - Water stress
  - Decreased fruit size and quality
  - Poor plant stand
  - Plant death

Irrigation research

Lampinen and DeMoranville

- When beds are too wet yield is less
- Part of the reason is poor fruit set and retention

Yield (bbl/a) in irrigation treatments. Differences in 2000 and 2001 were statistically different.

Irrig. Treat.	1999	2000	2001	Cumulative 3 years
"ideal"	207	80	193	472
wetter	187	50	120	357
		*	*	

Data bears out the observation that most beds are too wet
1999 was the driest year of the three

Distribution of uprights into classes. Zero refers to uprights that flowered but did not support any fruit. Numbers one through three refer to uprights that supported that number of fruit. *indicates significant difference within row. 1999 and 2000 data were similar.

	2001	
Upright type	Ideal (%)	Wetter (%)
Non-flowering	61.9	63.1
Zero	18.1*	23.5*
One	17.6*	11.2*
Two	2.2*	1.4*
Three or more	0	0

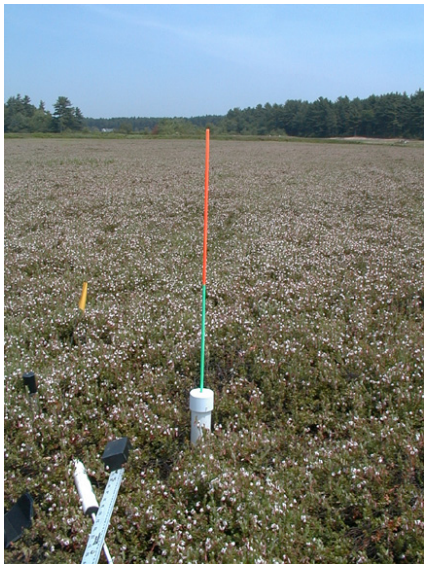
Failure to retain even one fruit accounted for decreased yield in standard (wetter) irrigation plots

Yellow vine

- Soil moisture is key
- Too wet or
  too dry
- Poor rooting
- Produced greenhouse
  symptoms
  if water table was too
  high or too low

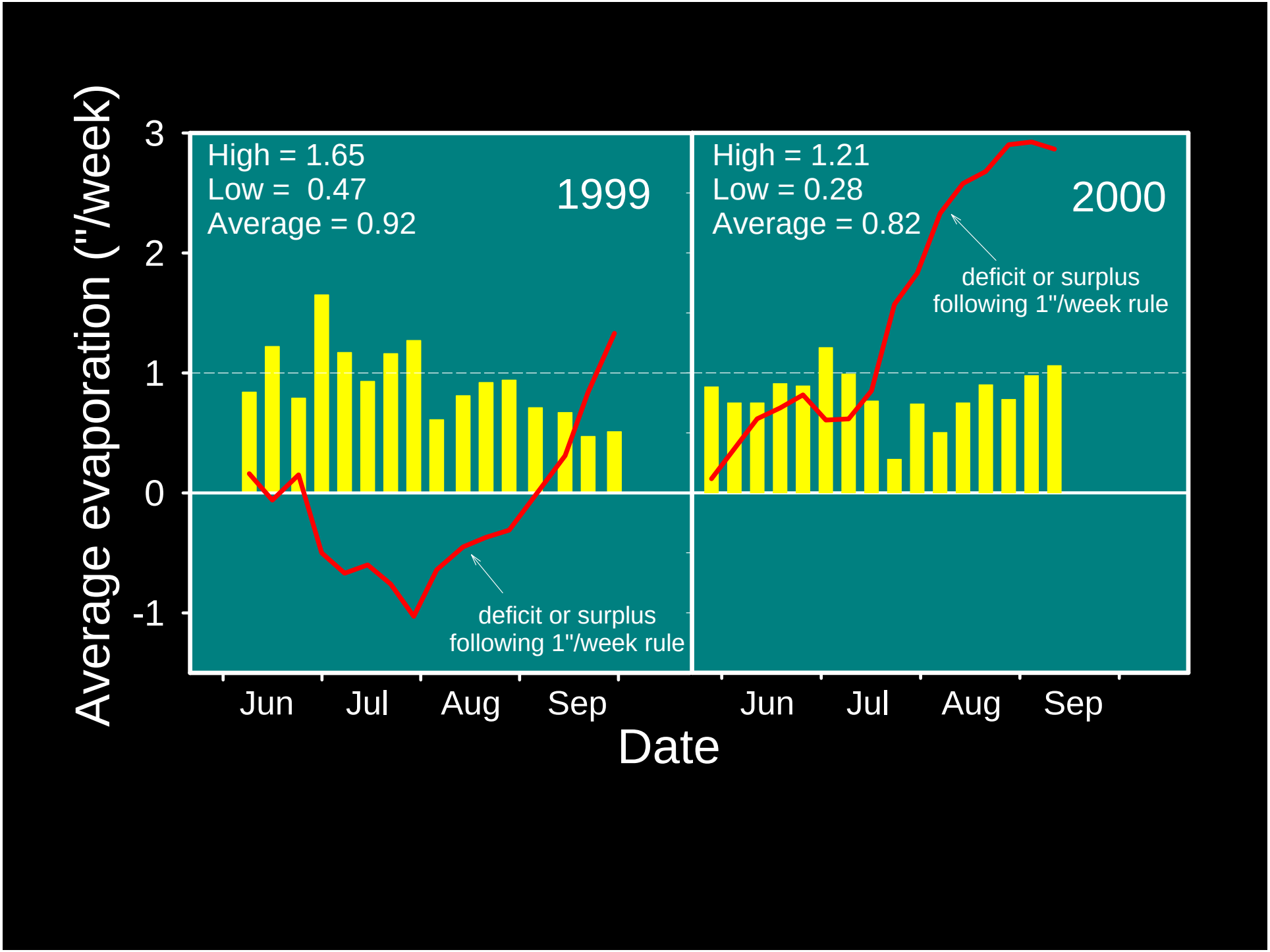
Important practices

- Drainage, drainage, drainage
- Insure adequate moisture into the fall, especially in drought years
- Properly schedule irrigation to avoid over- and under-watering



Both the calendar and 1”/week rule can lead to excess or deficiency

Evaporation gauge
was installed
at State Bog
during the summers
of 1999 and 2000


Average evaporation ("/week)
3
2
1
0
-1
High = 1.65
Low = 0.47
Average = 0.92
1999
deficit or surplus
following 1"/week rule
High = 1.21
Low = 0.28
Average = 0.82
2000
deficit or surplus
following 1"/week rule
Jun
Jul
Aug
Sep
Jun
Jul
Aug
Sep
Date

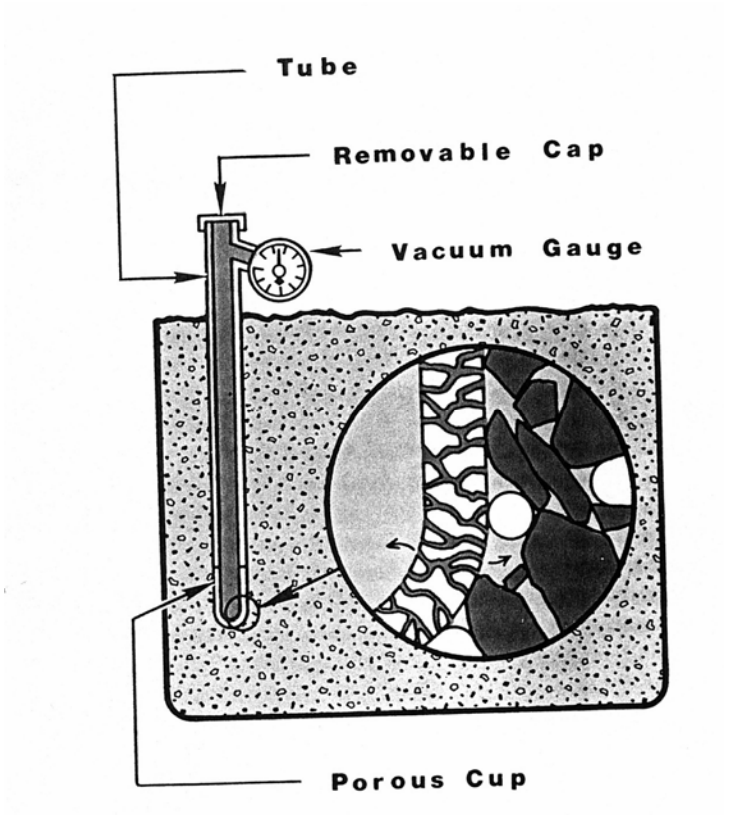
How much should I irrigate?

- Simple answer- enough to bring water table up to an adequate level to insure upper level adequate moisture (without flooding root zone)

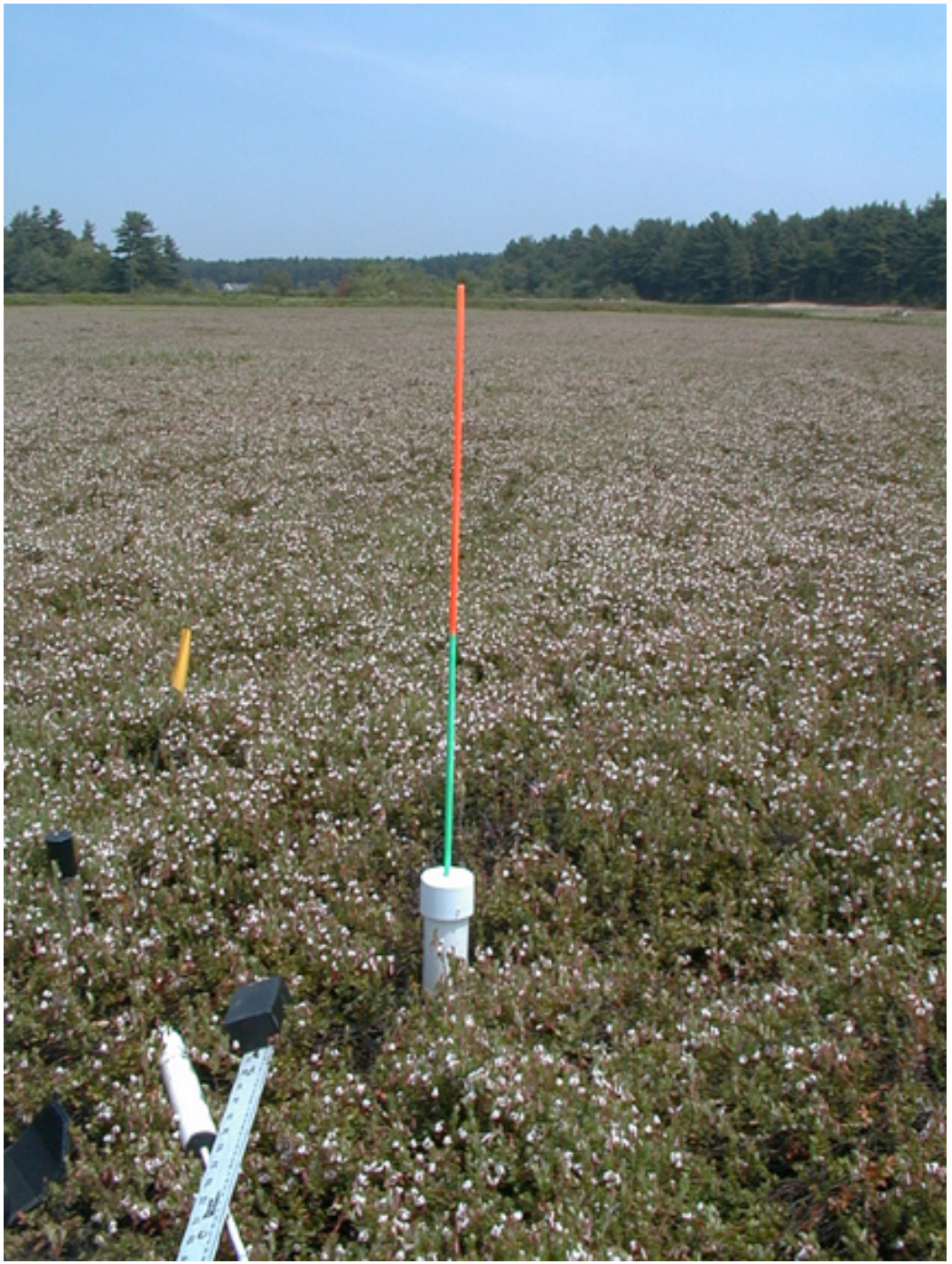
- You need to know where the saturation level is or what the moisture in the top levels is – you must monitor soil moisture to know this

Tensiometer

- Advantages
  - Capable of measuring midday depression in soil moisture in root zone
  - Useful with or without a water table present
- Disadvantages
  - Relatively insensitive to water level changes
  - Relatively expensive
  - Requires foot traffic on bed to read



Water level float



Water level float

- Advantages
  - inexpensive to build (fact sheet available)
  - low maintenance, not susceptible to freezing damage
  - do not require walking on bed to read
  - more sensitive to changes in water table than tensiometer
- Disadvantages
  - doesn’t register midday depression in root zone
  - only useful on beds with water table present

Moisture sensors – the future?

- Advantages
  - Can be automated
  - Lower maintenance than tensiometers
  - Do not require walking on bed to read
  - May be more sensitive to changes in water table than tensiometers
- Disadvantages?
  - Vandalism - animals
  - Uncertainty of utility in sandy soils – all types may not be suitable
  - Calibration data limited right now

- Questions?
- Grower experiences
- Expert information